NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

RETENTION EFFECTS OF IMMEDIATE GRADUATE EDUCATION IN THE NUCLEAR COMMUNITY

by

Sidney W. Cheek

June 2013

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This thesis examines how the timing of graduate education affects retention among officers in the nuclear community. Officers were divided into four main categories: Earned a master's degree in the first five years of their career, earned a master's after five years of their career, never earned a master's, and commissioned with a master's. The retention behavior of officers in each of these categories was compared to determine the effect on an officer's decision to remain in the Navy until promoted to CDR. Officers who earned their graduate degree in the first five years of their career had a positive effect on retention given the officer had attained the rank of Lieutenant Commander or had at least been commissioned in the nuclear community for ten years. The cost to send an officer to graduate school in the first five years is substantially less than sending him later in his career. The scholarship programs that send officers to graduate school early in their career make a substantial contribution to the nuclear community and should be utilized as a cost effective tool for all officers to earn their graduate degree before their Executive Officer sea tour.

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RETENTION EFFECTS OF IMMEDIATE GRADUATE EDUCATION IN THE NUCLEAR COMMUNITY

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LIST OF ACRONYMS AND ABBREVIATIONS

ACBD   Active Commissioning Base Date
ADBD   Active Duty Base Date
AFIT   Air Force Institute of Technology
AIC   Akaike's Information Criteria
CDR   Commander, USN
CSR   Core Skill Requirements
DH   Department Head
ESR   Education Skill Requirements
GEV   Graduation Education Voucher
IGEP   Immediate Graduate Education Program
JO   Junior Officer
JPME   Joint Professional Military Education
LCDR   Lieutenant Commander
LEAD   Leadership, Education, and Development Program
LT   Lieutenant, USN
NPS   Naval Postgraduate School
NROTC   Navy Reserve Officer Training Command
ODIS   Officer Distribution Information System
RMSE   Root Mean Square Error
ROTC   Reserve Officer Training Corps
TA   Tuition Assistance
UMD   University of Maryland
URL   Unrestricted Line Officer
USAFA   United States Air Force Academy
USMA   United States Military Academy
USNA   United States Naval Academy
VGEP   Volunteer Graduate Education Program
XO   Executive Officer
YCS   Years of Commissioned Service
YR   Year-group

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EXECUTIVE SUMMARY

In the Naval nuclear community, officers must have their master's degree before they can promote to CDR (O-5), which is at approximately 16 years of commissioned service. However, this community has a goal for all of its officers to get their master's before their sea tour as an Executive Officer, which is at approximately 12 years of commissioned service. This gives the officers in the nuclear community three opportunities to earn a master's degree. First, their opportunity as an Ensign (O-1) is possible before submarine officers enter nuclear power school or surface warfare officers report to a conventional ship. There are three programs that an officer may participate in to earn their master's at this time: Voluntary Graduate Education Program, Immediate Graduate Education Program, and Civilian-Funded Scholarship. The second opportunity is as a LT (O-3), and begins during their Junior Officer Shore Tour. An officer may participate in one of six programs during this tour to earn their master's: Burke, Olmsted, LEAD, GEV, Officer Scholarship, and a fully funded scholarship to NPS or a civilian institute. The third opportunity is afforded when an officer is a LCDR (O-4) during their Department Head Shore Tour. An officer may participate in the same programs as those of their Junior Officer Shore Tour. Two problems are encountered by the nuclear community during the LT and LCDR opportunities when sending its officers to get their master's degrees. First, it costs the Navy substantially more money to send the officers later in their career. Second, there are multiple billets that are required to be filled by a nuclear-qualified officer during their JO and DH Shore tours. While an officer is attending graduate school, the nuclear community maintains three goals for the officers to complete: earn a master's degree, complete Joint Professional Military Education (JPME), and fulfill the requirements of a subspecialty code.

The perception exists in the nuclear community that those officers who receive their master's degree as an O-1 are less likely to remain in the nuclear community until attaining the rank of O-5. Before responding to this misconception, this thesis provides detailed information on the subspecialty code system and how and when officers should complete Joint Professional Military Education. This thesis also gives a brief description

of when various graduate programs are available to an officer, what requirements he must fulfill to apply, and what service obligations he must commit to upon completion of the program.

Data from the Officer Distribution Information System (ODIS) is used for all officers who commission into the nuclear surface warfare and submarine communities. The data set contains only information for officers in the nuclear community from year-group 1983 to year-group 1992. Navy Personnel Command-42 Nuclear Submarines provided all of the data for this thesis. This data set is composed of all males because women were not allowed to serve in the nuclear community until 1994. All officers whose complete careers were as reservists were removed from the data set, leaving the final data set at 5,975 observations. Logistic regression was used as the primary statistical tool to conduct the analysis. The models found that an officer who attains the rank of LCDR and who earned his or her master's degree in the first five years of his or her commissioned career had a higher probability of remaining in the nuclear community until CDR over an officer who completed a master's degree after five years in the Navy. The models also found some basic demographic information that improved the chances of an officer remaining in the nuclear community until he attained the rank of CDR. If the officer attended one of the service academies, he was more likely to remain in the nuclear community until CDR. If the officer was not prior enlisted before commissioning, he was also more likely to remain in the nuclear community. In addition, an officer who was Caucasian, instead of a minority, was more likely to remain in the nuclear community until CDR.

Finally, this thesis broke down each graduate education program and identified whether the program met the graduate school requirements for the nuclear community. The minimum cost for the Navy to send an officer was based on pay charts from fiscal year 2013, as well as data from the Advanced Education and Competency Management office which is used for Manpower Management programming to reflect the cost of officers in fully funded graduate school programs. All of the graduate programs allowed an officer to earn a master's degree and a subspecialty code. However, only the Naval Postgraduate School and Leadership, Education, and Development program (LEAD)

connected with the United States Naval Academy made JPME easily accessible to officers. Based on the findings, the Navy saves on average between $50,000 and $70,000 per year to send an officer to graduate school in the first five years of commissioned service compared to what it spends later in his or her career. The Navy spends $180,000 to $200,000 less for an officer to complete the graduate program as an O-1 compared to later in his or her career, because the graduate programs available to O-1s are completed in one year while the other graduate programs last for two years and their salary is less as an O-1. Part of the reason for a graduate program lasting two years later in an officer's career is due to his or her need to be refreshed on basic skills necessary to complete the master's program. Overall the scholarship programs that send officers to graduate school early in their career make a substantial contribution to the nuclear community and should be utilized as a cost effective tool for all officers to earn their graduate degree before their Executive Officer sea tour.

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I.   INTRODUCTION

Graduate education is an integral part of an officer's professional development in the United States Navy. According to the Chief of Naval Operations, graduate education programs are established in the Navy for three basic reasons. First, they raise professional and technical competency while developing the capabilities of military officers so they can more effectively perform their required duties and carry out their assigned responsibilities. Second, these programs provide developmental incentives for military officers with the ability, dedication, and capacity for professional growth. Third, they develop and enhance the capacity of the Department of Defense to fulfill present needs, anticipated requirements, and future capability (CNO, 1991).

The goal of the U.S. Navy's nuclear community is for all officers to receive graduate education before becoming an Executive Officer, which is usually at the 12 year point. The community sets three objectives for each officer entering graduate school. First, the officer must receive a master's degree in a concentration that is beneficial to the Navy. Second, the officer should complete the Joint Professional Military Education (JPME Phase I and II). Third, officers must receive a sub-specialty code that will allow the Navy to fill various shore billets which require a specialized subset of skills. (LCDR B. Spillner, personal communication, December 22, 2011)

Currently multiple opportunities are available for an officer to attend graduate school. An officer may obtain their master's immediately after they graduate from college through programs such as Immediate Graduate Education Program (IGEP), Voluntary Graduate Education Program (VGEP), and Civilian-Funded Scholarships. Another option is to attend the Naval Postgraduate School, attend Distance Learning programs, or apply for other programs offered after completing an initial sea tour. These sea tours range from three to four years in length. Graduate School is typically accomplished on shore duty, which occurs between assignments known as sea tours when the officer can be sent out on deployment for months at a time. In the submarine community, there are generally two 2-year shore tour opportunities available to the officers.

The nuclear community faces an additional burden in this regard because there are shore billets that must be filled by nuclear trained officers during both windows of opportunity available for graduate school. This requirement reduces the opportunity for these officers to attend full time graduate education. The Navy must fill the shore billets that require nuclear training before detailing officers to graduate school. Due to these shore billet requirements and the nuclear community's retention rates, the community is unable to send all of their officers to graduate school before the 12-year mark (LCDR Spillner, personal communication, December 21, 2011).

A.   PURPOSE

During this time of budget cuts, the nuclear community is developing a cost effective strategy to meet its graduate education goals. This thesis addresses graduate education opportunities available to unrestricted line officers in the submarine and nuclear surface warfare communities as well as the cost taken on by the U.S. Navy to complete these programs. There is less of an operational and financial loss to send an officer who has not earned their warfare pin to graduate school. However, the current perception is that an officer who completed graduate school in one of the immediate graduate programs is less likely to complete a sea tour as a Commanding Officer compared to an officer who attended graduate school after their initial sea tour. This study will provide an analysis of the career progression and retention of officers who complete their master's degree immediately following their undergraduate coursework compared to the career progression of those who did not. The purpose of this thesis is to address the question: Does an officer earning a master's degree within the first five years of receiving his or her commission make him/her more or less likely to promote to O-5 or remain in the nuclear community for 16 years or greater? Answering this question will give evidence for when the best time that graduate school should be incorporated into an officer's career path in order to provide the greatest potential benefit to the Navy.

B. SCOPE AND LIMITATIONS

The scope of this thesis includes a discussion of graduate education goals for the nuclear community with various officers at the Naval Nuclear Propulsion Program Management Office in Washington, DC. The data used for this thesis was garnered through this office and only contained year groups from 1983 to 1992. The data included the officer's race, if he was previously enlisted, and source of undergraduate education. One limitation to this data set is that there were multiple places where an officer's data was not complete in the Officer Distribution Information System (ODIS) file. More detail on how this was dealt with for each variable can be found in Chapter IV. Also, due to the time frame of the data pulled, there were no females in the nuclear community; therefore this study was conducted on males only. The year groups 1993–1995 could have been pulled for this study; however, this would only allow for the two initial years with women in the study. To answer the primary question of this statistical data, analysis techniques will be used on the data received from the ODIS file.

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II. BACKGROUND

This chapter provides a brief overview of the details of the Navy subspecialty code, Joint Professional Military Education requirements, and the graduate school opportunities available to officers in the nuclear power community.

A. NAVY SUBSPECIALTY CODE

The Officer Subspecialty System was developed as a means of defining graduate education requirements for the Navy in accordance with DoD Directive 1322.1. The Navy Subspecialty Handbook defines a subspecialty as a professional discipline secondary to an officer's primary specialty, or designator, within the Unrestricted Line, Restricted Line, and Staff Corps officer communities. An officer must meet a set of Education Skill Requirements (ESRs) and Core Skill Requirements (CSRs) through a master's or higher degree program from an institution accredited by an agency recognized by the Department of Education in order to gain a subspecialty code. CSRs are a set of quantifiable skills, traits, and experiences, for each subspecialty code that an individual has received to meet the needs of the Navy. ESRs are the requirements that a master's degree or higher must meet in order to fulfill the CSRs. The subspecialty codes are used to facilitate the assignment of officers. A subspecialty-coded billet must have an officer assigned to it who has received that subspecialty code. Subspecialty-coded billets provide a set of guidelines for types of degrees required through the Navy's advanced education programs. The subspecialty codes an officer has earned can be found in Blocks 66–68 on the Officer Data Card and the formal education documented in Blocks 54–59.

To create a new subspecialty code, the Navy has set four guidelines that must be followed. First, the requirements necessary to earn the subspecialty code must not be overstated. Second, each subspecialty has a pyramidal structure that fosters healthy career progression. Third, the subspecialty billets must be distributed throughout the sea and shore activities to derive maximum utilization of subspecialist inventory. Fourth, there must be at least 15 validated requirements to start a graduate education program to meet that subspecialty requirement. The Navy's tool for establishing the subspecialty

requirements is the Total Force Manpower Management System managed by the Chief of Naval Operations. This system tracks all personnel resources (requirements, authorizations, and Fiscal Year Distributive Plan) for active military (officer/enlisted), reserve, civilian, contractor, temporary duty, transient, and other military services (The Navy Subspecialty Handbook, 2011).

Officer personnel who attend graduate school full time under any partially or fully funded program of 26 weeks or more are considered to be a part of funded graduate education. Fully funded education is defined by the Navy to be an officer who receives full pay and allowances, with the majority of the tuition and other schooling costs being assumed or paid for by the U.S. government or another organization, while pursuing a graduate degree. During partially funded education, the officer receives full pay and allowances with the majority of the tuition and other schooling costs paid for by the officer from his or her own personal funds while pursuing a graduate degree. The officer would attend school instead of performing usual military duties through both fully and partially funded graduate education. The Department of Defense closely monitors these programs to ensure maximum return of investment and retention. All officers who receive fully or partially funded graduate education are required to serve in a validated position no later than their second shore assignment following completion of that education. However, the Immediate Graduate Education Program, described in section E of this chapter, begins immediately after commissioning from the USNA or another civilian institution and does not have the same additional service obligation requirements.

B.   **JOINT PROFESSIONAL MILITARY EDUCATION (JPME)**

JPME has been embedded into the Professional Military Education (PME) system by the Department of Defense and is designed to fulfill the educational requirements for joint officer management as mandated by the Goldwater-Nichols Act of 1986. The JPME curriculum is comprised of five different levels designed to progressively develop the knowledge, analytical skills, perspectives, and values that are essential for U.S. officers to function in joint, interagency, intergovernmental, and multinational operations. The five levels of JPME include the following: pre-commissioning JPME taught through

accession sources, primary level of joint knowledge, JPME Phase I taught at or through Service intermediate-level and select senior-level colleges, JPME Phase II taught at Joint and Service Senior-level colleges. As of April 2010, all officers are required to complete JPME I prior to assuming command. In the nuclear community its goal is for officers to complete JPME I while earning a graduate degree. JPME I can also be completed as a non-resident through the College of Naval Command and Staff using Distance Learning completing Strategy and Policy in 17 weeks, National Security Decision Making in 17 weeks, and Joint Maritime Operations in 34 weeks, or using the CD-ROM Correspondence Course which allows 12 months for completion. JPME I can also be taken as a resident at various schools, such as the Intermediate College of Naval Warfare in three trimesters in Newport, Rhode Island or at the Naval Postgraduate School in the Joint Education Electives Program (JEEP). Officers can also receive JPME I credit after the completion as a resident at an international military college that is Combined Joint Chiefs of Staff approved. JPME II is a resident education that can be completed at the Naval War College, Joint Forces Service College, Industrial College of the Armed Forces, and Joint Advanced Warfighting School (P&R, 2012b).

C.   VOLUNTARY GRADUATE EDUCATION PROGRAM (VGEP)

The Chief of Naval Operations approved VGEP starting with the class of 1983 with the intent of accelerating the education of exceptionally capable Midshipmen to receive a master's degree and Navy-approved subspecialty code early in their career. The policy regarding this program is outlined in USNAINST 1560.3F. Midshipmen are selected for the VGEP program during their junior year and will begin graduate work at a university near the Naval Academy during the spring semester of their senior year. Up to 20 Midshipmen per class can pursue a graduate degree at a local university. The program usually takes approximately one year and will be completed by the December after they graduate. If a VGEP scholar is selected for the civilian-funded scholarship, they may terminate their VGEP at commissioning. In order to be selected for the VGEP program, the Midshipman must have a 3.2 GPA, at least a B in Aptitude, and a B in Conduct. At the Naval Academy, Midshipmen are given a letter grade A through F in Aptitude and Conduct. Aptitude is based off of rankings done each semester by each Midshipman's

Company Officer and peers. A Company Officer is a Lieutenant who is placed in charge of the professional development of about 130 to 150 Midshipmen ranging from freshmen to seniors. The conduct grade is based on how a Midshipman follows the rules and regulations established by the Naval Academy. Midshipmen selected for the nuclear power program at USNA accrue a five-year service obligation. VGEP scholars accumulate an additional seven month of obligated time in service because they cannot begin to pay back their initial service obligation until after they complete the graduate education course and check into their following command. During the VGEP program the officer will tailor their education plans in order to meet the requirements necessary to earn a Navy subspecialty code, but they will not complete any of the JPME requirements.

D.   JUNIOR LINE OFFICER ADVANCED EDUCATIONAL PROGRAM (NAVY BURKE PROGRAM)

Fifteen Midshipmen from the Naval Academy and fifteen Midshipmen in the Naval Reserve Officer Training Corps (NROTC) program can be selected for this scholarship each year. The individuals selected can be from the aviation, surface, and subsurface community and will complete their initial operational tours (about 30 to 36 months) before starting postgraduate studies. Officers will then receive a graduate degree in the field of science or engineering that can be completed within two years. If the Midshipman's desired curriculum is available at the Naval Postgraduate School (NPS) or Air Force Institute of Technology (AFIT), then they cannot attend a civilian institution. In order to apply for this scholarship the Midshipman must have at least a 3.2 GPA and be academically qualified in the science and engineering fields. On a case by case basis, officers may be able to resume studies for a Ph.D. after a follow-on tour based on the needs of the Navy (OPNAVINST 1520.18H).

E.   IMMEDIATE GRADUATE EDUCATION PROGRAM (IGEP)

This scholarship is also known as the Bowman Scholarship, named after Admiral Frank Bowman. A designated quota of 14 Midshipmen who have service selected submarines or nuclear surface warfare can attend NPS for a master's program in specified technical areas. Current M.S. degrees include Combat Systems, Undersea Warfare,

Electrical/Electronic Systems Engineering, Mechanical Engineering, and Space Systems Engineering. If a Midshipman wants to receive their master's in an area not listed they must submit a special request to the Advance Education Department of the Navy (N15) providing evidence of how the degree aligns with the needs of the Navy and how they are qualified to complete the master's program in a year. The newly commissioned Ensign must have at least a 3.0 GPA and maintain this GPA throughout their coursework at NPS. This will be a full time and fully funded one-year program. However, due to the rigor and short duration of this program, students are unable to complete the JPME requirements (USNA NOTICE 1520).

F.   CIVILIAN-FUNDED SCHOLARSHIP

Annually the Navy grants a quota of 20 Midshipmen graduating from USNA that can be selected for an immediate civilian-funded scholarship including the Truman, United Kingdom, and other international scholarships. The Midshipmen selected are generally the top 20 in the graduating class, not including the individuals who are commissioned into the Marine Corps. Midshipmen are eligible to apply for a civilian scholarship during their junior year at the Academy. This is a partially funded scholarship because the Navy will provide 50 percent of the tuition for each Midshipman. The remaining 50 percent must be paid for by a scholarship from the desired university or one of the following scholarship programs: Rhodes Scholarship, Gates Scholarship, Cambridge Scholarship, Marshall Scholarship, Churchill Scholarship, George J. Mitchell Scholarship, Rotary Ambassadorial Scholarship, William H.G. Fitzgerald Scholarship, Thomas G. Pownall Scholarship, John Nolan Scholarship, Otto A. Zipf (Heidelberg) Scholarship, Truman Scholarship, Hertz Fellowship, Guggenheim Fellowship, or 21 other scholarships focused on a specialized area of expertise. The Midshipman must meet various requirements to apply for each scholarship and the Naval Academy must nominate a Midshipman in order for them to be able to apply for some of the scholarships listed (ex: Truman) (USNA NOTICE 1520).

G. OLMSTEAD SCHOLARSHIP

Up to ten Naval Officers, who have completed three to eleven years of commissioned service, are selected each year to receive the Olmstead Scholarship. Each year a maximum of 25 Midshipmen can be nominated from the graduating class as an Olmstead Scholarship candidate. The focus for the Olmstead Scholarship is to study a foreign language at a foreign university approved by the Olmstead Foundation and the officer's service community for two years. A Midshipman must have a 3.2 GPA to receive a nomination. Other requirements include an aptitude for foreign language, success in sports, general adaptability, and will graduate in the Unrestricted Line officer community. All Midshipmen nominated must take the Defense Language Aptitude Battery and GRE to accompany their nomination. Officers selected for this program will receive a M.A, Diplome, License, or other graduate level equivalent in a field of study chosen by the scholar with concurrence of their service community. Social sciences, political science, and international relations are preferred areas of study; however, the service community can assure that the officer receives a graduate degree in a field that will receive a Navy subspecialty code. Completion of JPME is not a requirement of this scholarship program (USNA NOTICE 1520).

H. FULLY-FUNDED EDUCATION AT NAVAL POSTGRADUATE SCHOOL (NPS) AND CIVILIAN INSTITUTES (CIVINS)

NPS in Monterey, California is the primary source of graduate education to the officers in the Navy through the 74 different curriculums that are offered. Officers are able to attend the Naval Postgraduate School during a shore tour. In order to qualify for NPS, the officer must be academically qualified and possess promotional potential based off of Fitness Reports. There are only a set number of quotas available at NPS, based on the needs of the Navy. The goal of NPS is to prepare officers to fill sub-specialty positions and to reinforce the self-discipline, integrity and intellectual standards of the officer corps of the Naval Services. All programs available at NPS meet the specific needs of the Navy and cannot be offered at another institution for comparable cost and quality. Students at NPS are required to complete at least four credit hours in maritime strategy and developments in naval warfare if they are enrolled at NPS for three or more

academic quarters. Students who attend NPS under the IGEP program will fulfill this requirement by taking one course titled Strategy and War in the JPME I curriculum; however, due to time constraints they will not complete all JPME I courses. Students not under the IGEP program will fulfill the JPME I requirement by taking three additional classes: Joint Maritime Operations (part one), Joint Maritime Operations (part two), and Theater Security Decision Making. The curriculum at NPS is reviewed at least once every two years by the curriculum sponsor. Fiscal support for NPS is provided by the Department of the Navy (SECNAVIST 1524.2B).

There are 33 other fields that are available for officers to study at over 96 different civilian institutions nationwide. Each year approximately 22% of the graduate assignments for officers are slated to attend civilian institutions (CIVINS). An officer who desires to receive fully-funded education at one of these civilian institutions must first contact their detailer in order to ensure their eligibility for the program and quota availability. The officer must be accepted by the institution before detailers will issue orders. An officer is recommended to apply to three different universities that have inexpensive tuition rates in order to provide flexibility for budgeting purposes. The officer will be reimbursed for three transcript and application fees. An officer attending a fully-funded graduate program while on active duty is obligated to serve on active duty for a period that is three times the length of the education through the first year and one month for each month thereafter. This obligation will be served consecutively with other obligated service incurred before entering the graduate program, unless the officer is a recipient of a scholarship, grant, or fellowship. In that case, the obligation will be served concurrently (OPNAVNOTE1520).

I.   **GRADUATE EDUCATION VOUCHER PROGRAM (GEV)**

The purpose of the GEV program is for Unrestricted Line (URL) officers assigned to shore duty to obtain a Navy-relevant graduate education in selected areas of study during off duty hours. To be eligible for this program an officer must be an O-3 (including O-3 selects) through O-5 active duty URL officer with demonstrated superior performance as a Surface Warfare officer, Submarine Warfare officer, Naval Aviator,

Naval Flight officer, Special Warfare officer, or Explosive Ordnance Disposal officer. The applicant must be transferring to or currently stationed on shore duty, and must never have earned a Navy-sponsored graduate degree previously. The officer will receive an additional service obligation using the GEV benefits. After the completion of the graduate degree, the officer must remain on active duty for a minimum of two years or a period equal to three times the number of months of education up to a maximum of three years, whichever is greater. If the officer fails to complete the additional period of active duty, they must reimburse the United States for the cost of the graduate education received. This program will fund 100 percent of the graduate education cost (tuition, textbooks, registration fees, application fees, laboratory fees, computer software specifically required on the course syllabus, and any travel mandatory to participate in residency programs associated with distance learning) up to $20,000 per fiscal year for 24 months from time of initial course enrollment, not to exceed $40,000, for the entire program. If their program exceeds $40,000 the officer must use personal funds for the remainder of the expenses. An officer must earn a graduate degree that meets the education core skill requirements to earn at least one Navy subspecialty code at an institution accredited by the accrediting agency recognized by the Department of Education. Participants must complete their degree within 24 months of the initial course convening and maintain a 3.0 average GPA. The officer must begin the program no later than the end of the fiscal year for which selected. If operational requirements preclude this, a request to delay commencement must be submitted via the member's Commanding Officer prior to the end of the fiscal year (OPNAVINST 1520.37A).

J. OFFICER SCHOLARSHIP PROGRAM

This scholarship program allows selected officers to accept non-Navy funded financial aid to enroll in resident graduate education programs on a full-time basis while receiving full pay and benefits. The availability of this program is subject to a quota set by Navy requirements. This program is similar to the civilian-funded scholarship program available for Midshipman from the USNA. An officer can be considered for this program based on their career record, promotion potential, needs of the Navy, academic qualifications, particular field of study, and availability of funded student billets. At least

50 percent of the tuition must be paid by a non-Navy funded scholarship from an eligible donor. Selected officers must obtain qualifying scholarships and bear all additional cost associated with their academic program. Officers cannot use Tuition Assistance (TA) or Graduate Education Voucher (GEV) to augment scholarship funding. The graduate degree received under this program must meet all ESRs of a Navy subspecialty code. Students under this program will carry a full academic load, which is considered a minimum of 12 hours a semester, including summer sessions where they must complete six hours. The master's degree must be completed in 24 months. The minimum service obligation for this program is the same as the GEV program. An officer must gain admission to a college, obtain a scholarship from an eligible donor, and meet the subspecialty code requirements (OPNAVINST 1520.24C).

K.   LEAD PROGRAM

The LEAD program allows officers to earn a master's degree in Leadership, Education, and Development from the University of Maryland (UMD) and a 4500-series subspecialty code. The officer will complete one year of their master's degree on campus at UMD and then serve the following two years as a Company Officer or instructor at USNA while taking some classes at USNA. JPME I and an additional master's degree program in National Security and Strategic Studies are available on site for officers who are interested. After completing the program, officers are obligated to attend Department Head School in Newport, Rhode Island and complete two Department Head tours.

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III. LITERATURE REVIEW

Four theses written by graduates of the Naval Postgraduate School were used to formulate the methodology for this thesis. This chapter will compare and contrast the theses completed by these four students to the methods used to complete this thesis.

A. IMPACT OF GRADUATE EDUCATION ON THE PERFORMANCE AND RETENTION OF GENERAL UNRESTRICTED LINE OFFICERS

In 1991 LCDR Susan Jordan completed a thesis which focused on Unrestricted Line Officers who were qualified Surface Warfare Officers or Surface Warfare Officers in the reserves (designator 1100 or 1105) to determine whether or not graduate education had any effect on promotion boards. She used logistic regression with the response variable focusing on whether the officer left the Navy after LCDR either voluntarily or through failing to promote, or if the officer remained in the Navy to promote to Commander (CDR). She received her data from the Officer Promotion History File in Navy Officer Background Data. This variable is known as PROM.STAT in the ODIS system used in this thesis. The data for LCDR Jordan's thesis were from the Officer Promotion History File and Officer Master Record Files maintained at the Defense Manpower Data Center in Monterey, CA. She used demographic data such as race, age at commission, sex, commissioning source, and marital/dependent status. The educational variables she used were undergraduate degree, undergraduate grade-point average, mathematical qualification code, graduate education, and graduate school major. Jordan concluded that graduate education has a negative impact on retention prior to the LCDR promotion boards which occurs after about 10 years of commissioned service.

B. COST-BENEFIT ANALYSIS OF EARLY GRADUATE PROGRAMS FOR U.S. NAVAL ACADEMY GRADUATES

In 2003 LT Christopher Milner completed a thesis that focused on retention of officers who graduated from the USNA and participated in early graduate education programs such as VGEP and Civilian Scholarship Program. He used data from the Defense Manpower Data Center through the USNA Office of Institution Research. He

focused on retention rates in the surface warfare, submarine, special operations, and nuclear surface warfare communities. He added new independent variables to his model that were different from Jordan's, such as whether the Midshipman participated in varsity athletics and their overall order of merit from USNA. The basic hypothesis for this thesis is that officers who earned a master's degree through one of the early graduate education programs did not attrite at a different level than their peers. Milner goes into an in-depth cost analysis comparing the cost of officers in the VGEP and Scholarship programs with officers who did not participate. This thesis concluded that the overall populations of early graduate education participants are about 26% more likely to remain in the service at the six-year point. In the submarine community, early graduate participants were over 30% more likely to remain in the service at the six-year mark, and nuclear surface warfare officers were 45% more likely to remain in the service at the six-year mark. However, the results for submarine and nuclear surface warfare officers are flawed because all officers who participated in these programs did not begin to pay back their service obligation for attending USNA until after they completed their graduate degree, and therefore were required to remain in the Navy out of obligation until the six-year mark. Therefore, a bias is present in this analysis that makes early graduate participants seem more likely to remain in the Navy than in reality.

C. RETENTION ANALYSIS OF U.S. NAVAL ACADEMY IMMEDIATE GRADUATE EDUCATION PARTICIPANTS

In 2006 LT Maria Navarro expanded upon LT Milner's thesis and included the Midshipmen from the USNA that service selected into the aviation community. She also corrected for the fact that the officers who participated in the early graduate programs at USNA do not begin to pay back their five-year service obligation until after completion of graduate school. Navarro looked at the retention rates from officers in the submarine and nuclear surface community after seven, eight, nine, and ten years of commissioned service. She also used a binary logistic regression model to complete her analysis with the same basic hypothesis as LT Milner. She included a variable to find the effects of prior enlistment in her model that LT Milner did not have. Navarro's thesis concluded that submarine officers who participated in an early graduate program had a higher

retention rate after seven and nine years of commissioned service, but that there was no difference after eight and ten years of commissioned service. She did not break down the specifics for the nuclear surface warfare community. However, in general there was no difference in retention rates after seven years of commissioned service in her thesis.

D. ANALYSIS OF PROMOTION RATES TO LIEUTENANT COLONEL AND SELECTION FOR COMMAND FOR USMC AVIATION SUPPLY AND MAINTENANCE OFFICERS

In 2011 LtCol Michael Gonzalez completed a thesis that focused on what qualities in a Marine Corps Aviation Supply and Maintenance Officer are significant for promotion to Lieutenant Colonel. Also, he estimated a logistic regression to determine whether a particular MOS provides an advantage for selection to Lieutenant. Chapter VI of this thesis provides an organized and in-depth description of logistic regression. Although his thesis did not focus on graduate education, a model similar to LtCol Gonzalez's was used to answer the primary question in this thesis.

E. HOW IS THIS THESIS DIFFERENT?

This thesis will observe only officers in the nuclear surface warfare or submarine community. All of the officers in my data set will start with a designator of 1160 (Qualified Surface Warfare Officer), 1165 (Qualified Surface Warfare Reservist), 1170 (Qualified Submarine Officer), and 1175 (Qualified Submarine Reservist). The ODIS data source that was used for this thesis did not have some of the demographic information available from the Officer Master Record Files such as age at commission, mathematical qualification code, and undergraduate grade-point average. The main difference from LCDR Jordan's thesis is that this thesis will focus not only on the officers who received a graduate degree, but also when an officer received a degree in his or her career. All of the officers in this thesis were able to voluntarily make the decision to leave the Navy, because those who were forced to leave the Navy were removed from the data set. This thesis concentrates on how the timing of graduate school affects an officer's decision to remain in the Navy, whereas LCDR Jordan emphasized how graduate education affects promotion. A primary difference from LT Milner's thesis is

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that this thesis will give an overview of all of the graduate programs available to officers and give a brief comparison of the service obligations accrued and overall cost of the program. The officers observed in the data set used in this thesis did not graduate only from USNA. Also, this thesis will control for selection bias using conditioning methods unlike previous theses done on the topic of graduate education and retention. To gain more information and insight on the history of graduate education, reference LT Navarro's thesis, and to gain insight on modern trends in military education, reference LT Milner's thesis.

IV.   DATA AND VARIABLE DESCRIPTION

A.   DATA

The data used for this analysis was pulled by Pers-42N using the Department of the Navy's Online Distribution Information System (ODIS) from the Officer Personnel Dictionary File. The data includes all officers in the submarine and nuclear surface warfare communities from year group 1983 to 1992. During this time women were not allowed in the submarine or nuclear surface warfare community. In 1994 the Naval Academy revised the service selection policy and women were allowed, for the first time, to select warfare specialties under the same guidance as men. Women were now allowed in the nuclear community, with Mary R. Henson being the first female candidate to attend nuclear power school. However, females were still not allowed in the submarine community until February of 2010, when the Secretary of Defense signed a letter notifying Congress that the Submarine Forces were being opened to women. Since the data set only extends to officers who were commissioned up to 1992, there are no females in this data set. Also, all Personally Identifiable Information such as names or social security numbers, have been removed from the data.

There were two basic constraints to observe when selecting the year-groups. First, the data set begins with 1983 because this is the first year that officers were able to take part in the VGEP program. Second, each officer in the data set needs the opportunity to be an active duty commissioned officer for 16 years to create an accurate binary response variable based on whether an officer remained in the Navy for 16 years and attained the rank of O-5. Initially each officer had multiple entries that compounded on one another in the ODIS system for each year that they were a member of the U.S. Navy. The data was collapsed into one row of information per officer, with a total of 6,999 observations. However, all officers whose careers only involved time in the reserves were removed from the dataset. These officers could not contribute to the overall goal of each officer having a graduate degree before he can be selected for command, because reservists are not considered for command. After removing each of the officers who were only reservists, the data set consisted of 5,975 data points.

The model was then reduced to 4,979 data points, because all of the officers who left the Navy due to misconduct and poor performance were removed from the data set. The Loss Code in the ODIS data set identifies the reason an officer left the military. Unsatisfactory conduct and unacceptable conduct are two examples of loss codes that would not be included in this data set. The only reasons for an officer to leave the Navy in this data set are completion of required active service, early release from program through voluntary separation incentive, early release from program through special separation benefits, and sufficient service for retirement. The officers who remain in the data set are officers who were given the opportunity to decide if they were going to remain in the Navy as an active duty commissioned officer. All of the individuals who were removed from the data set left the Navy as a result of administrative separation, court martial, or involuntary discharge.

This data is used to answer the primary question: does receiving a graduate degree early in an officer's career affect the officer's decision to remain in the Navy to screen for command and reach the rank of O-5? In order to answer this question, detailed scrubbing of each data point was required to calculate how many years of each person's career were spent as an officer, enlisted, or reservist. At all times during an officer's career he is assigned a designator code. This four digit code identifies which community the officer is in, whether he is qualified or unqualified, and whether he is active duty or reservist. In the data provided, a date is given for each time an officer's designator changed. You can track whether an officer was active duty or a reservist throughout his or her complete career through his or her designators. However, there were multiple gaps because of insufficient data that is explained in further detail as the variables are broken down in section B of this chapter. In the data provided from ODIS, 2% (139) of the officers did not have specific dates for the changes in their designator code. However, for these officers their first designator code and current designator code were available. Only 2 of 139 officers had designator codes that indicated they transferred out of the nuclear surface warfare or submarine community. Those two officers were deleted from the data set leaving a total of 4,977.

B.   VARIABLE DESCRIPTION

The variables chosen replicate previous studies done at NPS on officer retention in the United States Navy and Marine Corps. Due to time constraints and lack of data received from the ODIS query, there are many variables that should be included in future studies on this topic. A list of variables that should be included can be found in Chapter VI.

1.   Dependent Variable

Based on the average submarine officer's career path, at the 10-year point the officer should be a LCDR. In the submarine community at the 14-year mark, an officer should have completed his or her Executive Officer (XO) tour and begin screening for command during his or her Post XO shore tour. The nuclear community strongly desires for all of its officers to have a graduate degree before the 14-year mark. The dependent variable for this thesis is binary and states whether an officer earned the rank of CDR. To distinguish which officers made the rank of CDR, the variable defined as "highest rank" in ODIS was the first place observed to assign a 0 or 1 to each officer. The dependent variable has a value of 1 if an officer earned the rank of CDR or higher and 0 otherwise, as defined in Table 1. However, in this data set, the highest rank of 69 of the officers (1 %) is unknown. If the highest rank is not defined in the ODIS system, then an officer with a career of 16 years or greater was determined as a success, because this is the average point in a submarine officer's career where he will make O-5.

Table 1.   Definition of Response Variable

Variable Label	Range
Response_16	= 1 if remains in the Navy for 16 years or greater and reaches the rank of 0–5 ; 0 otherwise

2.   Explanatory Variables

The following is a list of potential explanatory variables that were able to be gathered using the data received from ODIS. All of these variables will not be used in the final model because they distort the pure effect of what will happen if an officer earns his or her master's degree earlier in his or her career.

- Year-group (YR)
- Enlisted
- Subspecialty
- Race
- Service Academy
- Masters
- Two Masters
- Naval Postgraduate School
- Navy Scholarship

All independent variables in the data set were coded against a base officer reference group defined as the following:

- YR 83
- Not prior enlisted
- No subspecialty codes earned
- Caucasian
- Attended Service Academy
- Earned a Master after 5 years of active duty service
- Did not earn two masters.
- Did not receive a master's at Naval Postgraduate School
- Did not attend a Navy sponsored graduate or advance courses

a. Year-group

Data was drawn from the ten-year period 1983–1992. The following nine variables placed each officer within their specific year group. Table 2 breaks down how the binary variable will be a 1 for the officer's year-group he promoted with and zero for all other year-groups defined in this study. Year-group is the year an officer was commissioned into the United States Navy. When an officer screens for command, he will be compared to the peers in his year-group. In this thesis, 1983 is the base case that all the following years will be compared to.

Table 2.   Definition of Officer's Year-group

Variable Label	Range
YR 84	= 1 if officer was a part of YR 84; 0 otherwise
YR 85	= 1 if officer was a part of YR 85; 0 otherwise
YR 86	= 1 if officer was a part of YR 86; 0 otherwise
YR 87	= 1 if officer was a part of YR 87; 0 otherwise
YR 88	= 1 if officer was a part of YR 88; 0 otherwise
YR 89	= 1 if officer was a part of YR 89; 0 otherwise
YR 90	= 1 if officer was a part of YR 90; 0 otherwise
YR 91	= 1 if officer was a part of YR 91; 0 otherwise
YR 92	= 1 if officer was a part of YR 92; 0 otherwise

b. Enlisted

This value is found by comparing the Active Duty Base Date (ADBD) to the Active Commissioning Base Date (ACBD). As seen in Table 3, if an officer's ADBD is greater than his ACBD by two or more years then the officer is placed into the enlisted group. Two years is chosen because an individual cannot make it through the introductory training and specialty school in a year or less. An individual's ADBD could be greater than his ACBD by less than two years because the officer went through Officer Candidate School or another program prior to commissioning. In the data set, 18 of the officers did not have an ADBD. These 18 officers were given the enlisted value of 0.

Table 3.　　Definition of Enlisted Status

Variable Label	Range
Enlisted	= 1 if officers have 2 years or greater enlisted before commissioning; 0 otherwise

c.　　Subspecialty

As described in Chapter II, a subspecialty code can be earned in graduate school, through different jobs and training the officer will receive throughout his career. The longer an officer is in the military, the more subspecialties the officer should acquire. However, this also may be an indication of the officer's overall level of effort he is willing to put forth to obtain the training and education necessary to meet the Navy's needs. Table 4 shows how this variable is broken down into five subcategories with the base case being an officer who has never earned a subspecialty code.

Table 4.　　Definition of Quantity of Subspecialty Codes Earned

Variable Label	Range
SUBSPEC_1	= 1 if officer has one subspecialty code; 0 otherwise
SUBSPEC_2	= 1 if officer has two subspecialty codes; 0 otherwise
SUBSPEC_3	= 1 if officer has three subspecialty codes; 0 otherwise
SUBSPEC_4	= 1 if officer has four or more subspecialty codes; 0 otherwise

d.　　Race

Due to the majority of officers being Caucasian, the officers are separated into two distinct groups for analysis purposes. Table 5 shows the break-down of all officers in the data set by race. As seen in Table 6 the base case officer is Caucasian since 5,572 of the 5,977 officers fall into this category and all other officers are considered "non-white." For future studies using data from ODIS, the code for race was changed in September 2002.

Table 5.   Breakdown of Officers by Race

Race	Number of Officers
Native American	6
Asian	114
Caucasian	5,572
Native Hawaiian	2
African American	143
Other	77
Declined to Respond	61
Total	5,975

Table 6.   Definition of Race

Variable Label	Range
nonwhite	= 1 if the officer is not white; 0 otherwise

e.   *Service Academy*

There are multiple sources through which an officer may receive his commission. This variable captures the effect that a commissioning source may have on officer's decision to remain in the Navy until he is a CDR or for 16 years. Within this data set, officers were commissioned through the USNA, United States Air Force Academy (USAFA), United States Military Academy (USMA), and the Merchant Marine Academy. Officers can also complete Reserve Officer Training Command (ROTC) at a civilian institution and attend Officer Candidate School to earn a commission. The data does not distinguish an officer's commissioning source. However, the ODIS system provided where each officer received his undergraduate degree. From this information, if the officer was commissioned by one of the service academies, he can be distinguished from all other programs. Table 7 defines which officers receive a 1 or 0 for this binary variable.

Table 7. Definition of Service Academy

Variable Label	Range
Service Academy	= 1 if the officer did not attend the USNA, USAFA, USMA, or the Merchant Marine Academy; 0 otherwise

f. Master's

This variable captures the affect a master's degree has on whether an officer remains in the Navy for 16 years and makes it to O-5. Table 8 shows how the variable is broken down into MASTERS_START, which represents officers who had a master's degree before they earned their commission. An officer in the category MASTERS_JO earned his master's degree within the first 4 years of his career as an active duty officer. An officer in the category MASTERS_NO never earned a master's degree during his time in the Navy. If an officer is not in the MASTER_JO subgroup then he would have had to complete a sea tour and nuclear power school before attending graduate school. The base group for this variable is MASTER_SO, which represents officers who earns their master's degree after being in the Navy for at least 5 years.

Table 8. Definition of When an Officer Earned a Master's Degree

Variable Label	Range
MASTERS_START	= 1 if the officer had a master's degree before being commissioned as an officer; 0 otherwise
MASTERS_JO	= 1 if the officer earned a master's degree within the first five years of commissioned service; 0 otherwise
MASTERS_NO	= 1 if the officer did not earn a master's during his career in the Navy ; 0 otherwise
MASTER_SO	=1 if the officer earned a master's degree after the first five year of commissioned service; 0 otherwise

g. Two Master's

The typical officer will obtain one master's degree. Table 9 shows how this variable is defined to capture the effect of multiple master's degrees.

Table 9.   Definition for Multiple Master's

Variable Label	Range
2_MASTERS	= 1 if the officer has two or more graduate degrees; 0 otherwise

h. Naval Postgraduate School

Table 10 shows a breakdown of whether an officer received his graduate degree from the Naval Postgraduate School or a civilian institution. If an officer does not fall in one of these two categories then they did not receive a master's degree during his time in the Navy. Table 11 gives a clearer definition of the variable used in the model.

Table 10.   Breakdown of Graduate Degree Source

Graduate School	Number of Officers
Naval Postgraduate School	687
Civilian Institutions	981

Table 11.   Definition of Graduate Degree Source

Variable Label	Range
MONTEREY	= 1 if the officer attended Naval Postgraduate School; 0 otherwise

i. Navy Scholarship

A total of 1,668 officers in this data set earned a master's degree and of those 836 earned their degrees with the assistance of a Navy sponsored program. Chapter II included a brief description of all the graduate programs available to officers in the nuclear power community. Table 12 breaks down the binary variable based on if an officer received his master's through a Navy sponsored program or not. A Navy

sponsored program means the Navy paid for his tuition, books and fees in addition to his monthly stipend.

Table 12.   Definition of Scholarship Program

Variable Label	Range
NAVY_SPON	= 1 if the officer attended graduate school on a Navy sponsored scholarship; 0 otherwise

The ODIS system has an education variable that labels the sponsor for the graduate program each officer completed, which is used to define the NAVY_SPON variable. The subcategories include: the Burke Scholarship, VGEP, Navy Sponsored Scholarship, Advance Education Program, and scholarship programs in the form of grants, fellowships, or scholarship received from an outside source. Table 13 shows the total number of officers in each graduate program. This variable was not utilized in the model because the ODIS system did not label 83% (4,974) officers who earned a master's degree.

Table 13.   Breakdown of How Officers Earned their Graduate Degree

Graduate Program	Number of Officers	Percentage of Total
Burke Scholarship	9	Less than 1%
Advanced Education Program	55	0.9%
VGEP	55	0.9%
Navy Sponsored Scholarship	836	14%
Scholarship Program (grants, fellowships, and scholarships)	46	0.7%
Unlabeled	4974	83%

3. Summary

There are a total of 9 variables defined for the full model and 4,977 individual officers observed. Chapter V discusses the methodology and results of the multivariate logistic regression model used for analysis.

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V. METHODOLOGY, MODELS, AND RESULTS

A. METHODOLOGY

A logistic regression model is used to determine if the nine independent variables described in Chapter IV have a statistically significant influence on an officer's decision and ability to remain in the Navy until attaining the rank of CDR or completing at least 16 years of active duty service. The logistic regression model is used because the dependent variable is dichotomous and fulfills the desirable properties outlined by Hosmer and Lemeshow. According to Hosmer and Lemeshow (2000) a logistic regression is useful when the dependent variable has many desirable properties: its parameters are linear, may be continuous, and may range from negative to positive infinity depending on the range of x. (p. 6) To estimate the parameters for the independent variables, the method of maximum likelihood is used in JMP Pro 9, a statistical software package. The parameter is considered significant if its p-value is greater than 0.05. To gain a more complete understanding of the properties of a logistic regression, see Hosmer and Lemeshow's Applied Logistic Regression, second edition (2000).

To select which variables to include in the final model, a step-wise regression using backward selection method and minimizing Akaike's Information Criteria (AIC) within JMP was utilized. According to David Beal (2012), the model with the smallest AIC is the best because it minimizes the difference from the given model to the "true" model. Another statistical test used is the chi-square test, to determine if the fitted model with additional variables is better than a model that includes only the intercept. A p-value of 0.05 also serves as a gauge for the chi-square test.

JMP provides a summary of fit for each model. The summary of fit includes R^2, Root Mean Square Error (RMSE), Mean of Response, and total number of observations. The best model will have an R^2 close to 1.0, meaning that the majority of the variation around the mean can be attributed to the model rather than random error. The Root Mean Square Error reveals what percentage of the variability is unexplained, and the mean of

response is the overall mean of the response values for the base model which all the other models are compared to. These tests will measure the accuracy of the different models.

B.   THE MODELS AND RESULTS

Two different logistic regression models were built to answer the primary question: Does earning a master's degree in the first five years as a commissioned officer increase the likelihood he/she promotes to O-5 or at least remains in the community for 16 years? There is an empirical problem with estimating this model due to the selection bias caused by use of graduate school as a retention tool in the military. When all of the data points are used in the model there is an unrealistic level of statistical significance for officer who received his masters after five years of commissioned service. This level of significance is unrealistic because all officers who earn their degree later in their career are required to remain in the Navy for at least ten years. This accounts for them starting their masters after five years of commissioned service, going to graduate school for two years and serving three years of payback time, therefore these officers do not make the same choice to remain in the Navy as those who attended graduate school early in their career until after ten years of commission service. To fix this issue I used two approaches, which were very similar. The first approach is to condition the data on the fact that every officer in the data set has been commissioned for at least 10 years. Eliminating officers commissioned for less than 10 years limits the data set used for the first model to a total of 1,895 data points. The second approach conditions on the data on the fact that every officer in the data must have at least attained the rank of LCDR (O-4). There are a total of 1,839 data points in the second model after eliminating all of the officers who do not reach the rank of LCDR.

Tables 14 and 15 give a clearer depiction of why the two models must be conditioned on ten years of commissioned service and attaining the rank of LCDR to fix the problem of selection bias. Table 14 breaks down the percentage of officers who remained in the nuclear community after 7, 10, 12, 14, and 16 years of commissioned service. This table encapsulates the complete data set prior to any condition applied to control for selection bias, however all officers whose complete career was served in the

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reserves have been removed. Table 15 displays 12, 14 and 16 YCS because the majority of officers must remain in the Navy for at least 12 years before completing their second shore tour. The data used for Table 15 has been conditioned on the fact that every officer has attained the rank of LCDR. In Table 14 there is a drastic difference in percentage values for officers who earned their master's degree in the first five years versus after five years; however, there is very little differences in the percentage values for these two columns in Table 15.   The difference in these two tables is due primarily to the selection bias present in Table 14. Most of the officers that make up the data set for Table 14 would never make it to 10, 12, 14 or 16 YCS because they chose to get out after their initial obligation. Officers who earn their masters after five years are obligated to remain in the military for at least 8 years, therefore Table 14 gives a false sense that officers who receive their masters after five years are more likely to remain in the Navy than officers who earned their masters prior to five years of commissioned service. Table 15 corrects for this using conditioning, and focuses only on those officers that have made it to the rank of LCDR.

Table 14.   Nuclear Officer Retention Based on Timing of Graduate Education

Years of Commissioned Service	Before Commissioned	First Five Years	After Five Years	Never
YCS 7	44.1%	58.8%	98.9%	40.0%
YCS 10	30.8%	23.5%	97.3%	16.3%
YCS12	26.4%	23.5%	92.4%	13.5%
YCS14	23.5%	23.5%	81.9%	11.3%
YCS 16	23.5%	23.5%	79.8%	10.0%

Table 15.   Nuclear Officer Retention Based on Timing of Graduate Education and Conditioned on whether an Officer Remains in the Navy until LCDR (O-4)

Years of Commissioned Service	Before Commissioned	First Five Years	After Five Years	Never
YCS12	72.4%	94.2%	97.9%	92.1%
YCS14	72.4%	86.9%	92.7%	82.7%
YCS 16	72.4%	85.5%	86.0%	73.7%

The base logistic regression model shown in Figure 1 does not include any information about education. Parameters will be added to determine how graduate education affects the likelihood an officer attains the rank of CDR.

$$Logit: Will\ an\ officer\ remain\ in\ the\ Navy\ until\ he\ attains\ CDR$$
$$= \beta_0 + \beta_1 X_{YR84} + \beta_2 X_{YR85} + \beta_3 X_{YR86} + \beta_4 X_{YR87} + \beta_5 X_{YR88}$$
$$+ \beta_6 X_{YR89} + \beta_7 X_{YR90} + \beta_8 X_{YR91} + \beta_9 X_{YR92} + +\beta_{10} X_{SUBSPEC\_1}$$
$$+ \beta_{11} X_{SUBSPEC\_2} + \beta_{12} X_{SUBSPEC\_3} + \beta_{13} X_{SUBSPEC\_4} + \beta_{14} X_{Enlisted}$$
$$+ \beta_{15} X_{nonwhite}$$

Figure 1.   Base Logistic Regression Model

1.   Conditioned on Ten Years of Commissioned Service

A backward step-wise selection in JMP minimizing the AIC value was used to select the best education variables to add to the model conditioned on the fact that every officer had at least 10 years of commissioned service (TEN model). In order to test if sending an officer to graduate school earlier or later in his career will make him more or likely to remain in the Navy until O-5, the variables MASTER_SO and MASTER_JO were included in the TEN model. However, MASTER_JO was not selected by JMP to be in the model during the step-wise selection process. Also, the variables SUB_1 and SUB_2 were not selected.   The model created using step-wise selection gave a starting point to see which variables must be added to the base model. The step-wise model is not the final model used because upon further investigation it became evident that the variables MONTEREY, NAVY_SPON and 2_MASTERS that were selected to be added to the base model by JMP should not be included because they capture some of the effect MASTER_JO and MASTER_SO have on the response variable. To capture the pure effect of what will happen if an officer earns his master's degree earlier in his career, the variables MONTEREY, NAVY_SPON and 2_MASTER must be eliminated from the final model. NAVY_SPON distorts the pure effect because an officer who earns a

masters after at least five years of active duty commissioned service is more likely to be in a Navy sponsored program and/or attend the Naval Postgraduate School than those who earned their masters in the first five years of commissioned service or before they were commissioned. Table 16 estimates the parameters for the model including all of the education variables given a total of 1,895 observations.

Table 16. Parameter Estimates: Effect of Various Factors on whether an Officer Remains in the Navy until Promoted to O-5 (Conditioned on Ten Years of Commissioned Service with 1,895 observations)

Term	Estimate	Std Error	ChiSquare	Odds Ratio	p-value
Intercept	-3.329	0.629	28.00	0.036	<.0001*
Timing of Master's Degree *(reference: earned after 5 years)*					
before commissioned	-0.405	0.186	4.71	0.667	0.029*
first 5 years	0.206	0.203	1.03	1.229	0.309
Never	-0.364	0.067	29.68	0.695	<.0001*
Year-group *(reference: 1983)*					
Year-group 1984	0.177	0.106	2.80	1.194	0.094
Year-group 1985	0.445	0.111	16.07	1.560	<.0001*
Year-group 1986	0.499	0.115	18.70	1.647	<.0001*
Year-group 1987	0.339	0.110	9.45	1.404	0.002*
Year-group 1988	0.271	0.103	6.80	1.311	0.009*
Year-group 1989	0.35	0.113	9.80	1.419	0.001*
Year-group 1990	0.338	0.106	10.17	1.402	0.001*
Year-group 1991	0.464	0.113	16.96	1.590	<.0001*
Year-group 1992	0.578	0.113	26.27	1.782	<.0001*
Subspecialty *(reference: never earned a subspecialty)*					
One subspecialty	-0.053	0.102	0.27	0.948	0.605
Two subspecialties	-0.049	0.112	0.20	0.952	0.654
Three subspecialties	0.188	0.120	2.47	1.207	0.115
Four or more subspecialties	0.553	0.133	17.20	1.738	<.0001*
Demographics					
Did not attend service academy	-0.241	0.060	15.78	0.786	<.0001*
Greater than two years enlisted	-0.441	0.063	47.70	0.643	<.0001*
Not Caucasian	-0.159	0.083	3.68	0.853	0.055

The ten years model used to answer this thesis primary question included all of the variables listed above. The Prob>ChiSq value of less than .001 in Table 17 gives evidence that the model with all of the additional education variables added better explains the response variable than the model with only the intercept. The RMSE value of 0.4453 can be interpreted as 44.53% of the variability is unexplained in this model. The model has a misclassification rate of 0.3077, which means that the model accurately classifies officers 70% of the time as either staying in the Navy until O-5 or not remaining in the Navy until O-5. The Prob>ChiSq value, shown under Lack of Fit, suggest that additional terms need to be added to the full model in order to explain the variability in the response variable.

Table 17.   The Whole Model Test for TEN YEAR Model

Whole Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	136.6344	19	273.2688	<.0001*
Full	1098.5702			
Reduced	1235.2046			

RSquare (U)	0.1106
AICc	2237.59
BIC	2348.08
Observations (or Sum Wgts)	1895

Measure	Training	Definition
Entropy RSquare	0.1106	1-Loglike(model)/Loglike(0)
Generalized R-Square	0.1843	$(1-(L(0)/L(model))^{(2/n)})/(1-L(0)^{(2/n)})$
Mean -Log p	0.5797	$\sum -Log(p[j])/n$
RMSE	0.4453	$\sqrt{\sum(y[j]-p[j])^2/n}$
Mean Abs Dev	0.3964	$\sum |y[j]-p[j]|/n$
Misclassification Rate	0.3077	$\sum (p[j]\neq pMax)/n$
N	1895	n

Lack Of Fit

Source	DF	-LogLikelihood	ChiSquare
Lack Of Fit	433	268.1920	536.3841
Saturated	452	830.3782	Prob>ChiSq
Fitted	19	1098.5702	0.0005*

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a.   *Interpreting the Results*

The most important finding in this model is that sending an officer to get his master's degree in the first five years of his career has no significant effect on whether the officer will attain the rank of CDR. A key demographic result from this regression is extremely low p-values for officers who attended one of the service academies and for officers who had greater than two years of prior enlisted service. The p-values for both of these variables are less than 0.001, which indicates that these are both significant variables in the model. Both variables had an odds ratio of less than one, which can be interpreted as individuals who did not attend one of the service academies and officers who had less than two years of prior enlisted service are more likely to remain in the nuclear community until reaching the rank of CDR. Also a p-value of less than 0.001 gives evidence that the more subspecialties an officer earns the more likely he is to remain in the Navy until O-5. This finding could be because an officer with a high number of subspecialties would more likely have had to have more time in service. However, if a junior officer has earned a high number of subspecialties he may be a good candidate to send to graduate school because he is aware and motivated to meet the needs of the Navy. It would be very valuable to include more variables that explain the demographics of each officer in order to find commonality among the officers who remain in the nuclear community until they reach the rank of CDR. The demographics that these officers share would target what kind of officers the Navy should focus on sending to graduate school because they are more likely to remain in the Navy as an active duty nuclear officer until they reach the rank of CDR.

Table 18. Interpretation of Estimate Coefficients with
Significance in the Ten-year Model

Term	Estimate	Odds Ratio	Interpretation
Joined the Navy with a master's degree	-0.405	0.667	An officer who earned his master's degree before they were commissioned is associated with lower odds of staying in the Navy until O-5, relative to an officer who earned their master's degree after five years of service.
Never earned a master's degree	-0.364	0.695	An officer who never earned his master's degree is associated with lower odds of staying in the Navy until O-5, relative to an officer who earned their master's degree after five years of service.
Attended a Service Academy	-0.241	0.786	An officer who did not go to one of the service academies is associated with lower odds of staying in the Navy until O-5, relative to an officer who attended a service academy.
Prior enlisted	-0.441	0.643	An officer who spent greater than 2 years enlisted is associated with lower odds of staying in the Navy until O-5, relative to an officer without prior enlisted service.
Earned four or more subspecialty codes	0.553	1.738	An officer who has earned four or more subspecialty code is associated with higher odds of staying in the Navy until O-5, relative to an officer with three or fewer.
Year-group 1985	0.445	1.560	An officer who was commissioned in 1985 is associated with higher odds of staying in the Navy until O-5, relative to an officer commissioned in 1983.
Year-group 1986	0.499	1.647	An officer who was commissioned in 1986 is associated with higher odds of staying in the Navy until O-5, relative to an officer commissioned in 1983.
Year-group 1987	0.339	1.404	An officer who was commissioned in 1987 is associated with higher odds of staying in the Navy until O-5, relative to an officer commissioned in 1983.
Year-group 1988	0.271	1.311	An officer who was commissioned in 1988 is associated with higher odds of staying in the Navy until O-5, relative to an officer commissioned in 1983.
Year-group 1989	0.35	1.419	An officer who was commissioned in 1989 is associated with higher odds of staying in the Navy until O-5, relative to an officer

Term	Estimate	Odds Ratio	Interpretation
			commissioned in 1983.
Year-group 1990	0.338	1.402	An officer who was commissioned in 1990 is associated with higher odds of staying in the Navy until O-5, relative to an officer commissioned in 1983.
Year-group 1991	0.464	1.590	An officer who was commissioned in 1991 is associated with higher odds of staying in the Navy until O-5, relative to an officer commissioned in 1983.
Year-group 1992	0.578	1.782	An officer who was commissioned in 1992 is associated with higher odds of staying in the Navy until O-5.1983, relative to an officer commissioned in 1983.

2. Conditioned on Obtaining the Rank of LCDR

A backward step-wise selection in JMP minimizing the AIC value was also used to select the best education variables to add to the model condition on the fact that every officer attained the rank of LCDR (LCDR model). The LCDR model is set up exactly the same as the TEN YEAR model, however there are 56 less observations because those 56 individuals completed ten years of service but never attained the rank of LCDR. The importance of comparing the TEN YEAR model and the LCDR model is to observe how the removal of 56 individuals can alters the significance of each variable. The variables relevant to when an individual received a masters are of particular importance because the significance level increases in the LCDR model is greater than in the TEN YEAR model.

After completing the step-wise selection the only variables not selected were SUB_1, SUB_2, and YR84. However, these variables will be used in the final model. The variables MONTEREY, NAVY_SPON, and 2_MASTERS are eliminated to maintain the pure effect of the variables that pertain to the main question asked by this thesis MASTER_START, MASTER_JO, and MASTER_NO. The three variables are eliminated for the same reason they were eliminated in the model conditioned on ten years of active duty commissioned service. Table 19 estimates the parameters for the LCDR model with all of the education variables given a total of 1,839 observations.

Table 19.   Parameter Estimates: Effect of Various Factors on whether an Officer Remains in the Navy until Promoted to O-5 (Conditioned on Attained Rank Greater than LCDR (O-4) with 1,839 Observations)

Term	Estimate	Std Error	ChiSquare	Odds Ratio	p-value
Intercept	-2.62	0.707	13.71	0.073	0.0002*
Timing of Master's degree *(reference: earned after 5 years)*					
before commissioned	-0.414	0.202	4.17	0.661	0.041*
first 5 years	0.430	0.211	4.15	1.537	0.041*
Never	-0.299	0.068	19.24	0.742	<.0001*
Year-group *(reference: YR83)*					
YR84	0.095	0.111	0.75	1.100	0.387
YR85	0.292	0.112	6.72	1.339	0.009*
YR86	0.372	0.118	9.80	1.451	0.001*
YR87	0.233	0.114	4.15	1.262	0.041*
YR88	0.182	0.108	2.82	1.200	0.092
YR89	0.246	0.117	4.41	1.279	0.035*
YR90	0.213	0.109	3.80	1.237	0.051
YR91	0.344	0.115	8.84	1.411	0.003*
YR92	0.419	0.114	13.34	1.520	0.0003*
Subspecialty *(reference: never earned a subspecialty)*					
One subspecialty	-0.073	0.105	0.48	0.930	0.486
Two subspecialties	-0.065	0.115	0.32	0.937	0.571
Three subspecialties	0.151	0.123	1.51	1.163	0.219
Four or more subspecialties	0.493	0.135	13.18	1.637	0.0003*
Demographics					
Did not attend service academy	-0.234	0.062	14.32	0.791	0.0002*
Greater than two years enlisted	-0.395	0.064	37.32	0.674	<.0001*
Not Caucasian	-0.232	0.081	8.07	0.793	0.004*

The final model used to answer the questions in this thesis included all of the variables listed above. Table 20 shows that the model with all of the additional education variables added is better than the model fitted with only the intercept because the Prob>ChiSq located under Whole Model Test is significant with a p-value of less than .001. The R^2 value is 0.0961 and the RMSE is 0.4447, which can be interpreted as 44.47% of the variability is unexplained in this model. The model has a misclassification rate of 0.3094, which shows that the model accurately classifies officers 70% of the time

as either staying in the Navy until CDR or not remaining in the Navy until CDR. For goodness of fit, shown under the Lack of Fit section, the p-value of 0.0027 is less than 0.05 and therefore significant. This low p-value is interpreted as additional terms need to be added to the model in order to explain the variability in the response variable which indicates whether an officer attains the rank of CDR or not.

Table 20.   The Whole Model Test for LCDR Model

Whole Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	112.9650	19	225.9301	<.0001*
Full	1063.0516			
Reduced	1176.0166			

RSquare (U)	0.0961
AICc	2166.57
BIC	2276.44
Observations (or Sum Wgts)	1839

Measure	Training	Definition
Entropy RSquare	0.0961	1-Loglike(model)/Loglike(0)
Generalized R-Square	0.1602	$(1-(L(0)/L(model))^{(2/n)})/(1-L(0)^{(2/n)})$
Mean -Log p	0.5781	$\sum -Log(\rho[j])/n$
RMSE	0.4447	$\sqrt{\sum(y[j]-\rho[j])^2/n}$
Mean Abs Dev	0.3951	$\sum |y[j]-\rho[j]|/n$
Misclassification Rate	0.3094	$\sum (\rho[j]\neq\rho Max)/n$
N	1839	n

Lack Of Fit

Source	DF	-LogLikelihood	ChiSquare
Lack Of Fit	425	255.3092	510.6183
Saturated	444	807.7424	Prob>ChiSq
Fitted	19	1063.0516	0.0027*

a.   Interpreting the Results

This model is extremely important because it gives evidence that an officer who gets his master's in the first five years of his career is more likely to remain in the Navy until CDR than an officer who gets his master's degree after five years of active duty commissioned service. This finding is supported by the p-value, found in Table 19, for an officer earning a master's degree in the first five years of his career is

0.041. Table 21 provides more findings that explain the potential effects of when an officer receives his masters may have on his career. This model also gives insight on the types of demographics that are more likely to remain in the Navy until O-5, because all three demographic variables have a p-value of less than 0.05. The three variables also have an odds ratio of less than one, which can be interpreted as an officer who went to one of the service academies are less likely to remain in the nuclear community until O-5 then those who did not. Also, officers who have more than two years of enlisted service are less likely to remain in the nuclear community until O-5 then officers who were prior enlisted. Finally officers who are minorities are less likely to remain in the nuclear community until O-5 then officers who are Caucasian. Table 21 describes in detail all of the variables that had a p-value that was less than 0.05 in the model.

Table 21.   Interpretation of Estimate Coefficients with Significance in the LCDR Model

Term	Estimate	Odds Ratio	Interpretation
Attended a Service Academy	-0.234	0.791	An officer who did not go to one of the service academies is associated with lower odds of staying in the Navy until O-5, relative to an officer who attended a service academy.
Prior enlisted	-0.395	0.674	An officer who spent greater than 2 years enlisted is associated with lower odds of staying in the Navy until O-5, relative to an officer without prior enlisted service.
Non-white	-0.232	0.793	An officer who is not white is associated with lower odds of staying in the Navy until O-5, relative to one who is white.
Joined Navy with a master's degree	-0.414	0.661	An officer who earned his master's degree before they were commissioned is associated with lower odds of staying in the Navy until O-5, relative to an officer who earned their master's degree after five years of service.
Earned master's degree in first five years.	0.430	1.537	An officer who earned his master's degree within the first 5 years commissioned in the Navy is associated with higher odds of staying in the Navy until O-5, relative to an officer who earned their master's degree after five years of service.

Term	Estimate	Odds Ratio	Interpretation
Never earned a master's degree	-0.299	0.742	An officer who never earned his master's degree is associated with lower odds of staying in the Navy until O-5, relative to an officer who earned their master's degree after five years of service.
Earned more than four subspecialty codes	0.493	1.637	An officer who has earned four or more subspecialty codes is associated with higher odds of staying in the Navy until O-5, relative to an officer with three or fewer.
Year-group 1985	0.292	1.339	An officer who was commissioned in 1985 is associated with higher odds of staying in the Navy until O-5, relative to an officer commissioned in 1983.
Year-group 1986	0.372	1.451	An officer who was commissioned in 1986 is associated with higher odds of staying in the Navy until O-5, relative to an officer commissioned in 1983.
Year-group 1987	0.233	1.262	An officer who was commissioned in 1987 is associated with higher odds of staying in the Navy until O-5, relative to an officer commissioned in 1983.
Year-group 1988	0.182	1.200	An officer who was commissioned in 1988 is associated with higher odds of staying in the Navy until O-5, relative to an officer commissioned in 1983.
Year-group 1989	0.246	1.279	An officer who was commissioned in 1989 is associated with higher odds of staying in the Navy until O-5, relative to an officer commissioned in 1983.
Year-group 1990	0.213	1.237	An officer who was commissioned in 1990 is associated with higher odds of staying in the Navy until O-5, relative to an officer commissioned in 1983.
Year-group 1991	0.344	1.411	An officer who was commissioned in 1991 is associated with higher odds of staying in the Navy until O-5, relative to an officer commissioned in 1983.
Year-group 1992	0.419	1.520	An officer who was commissioned in 1992 is associated with higher odds of staying in the Navy until O-5, relative to an officer commissioned in 1983.

The model conditioned on whether an officer earns the rank of LCDR gives reason to believe that if an officer earns the rank of LCDR, then those who received his master's in the first five years of his career are more likely to promote to CDR than one who receive his master's after the first five years of his career. However, this section will focus on the officers who were removed from the LCDR model to control for selection bias. All officers whose complete career was served as a reservist are removed from the data set used in Tables 22 through 27. Table 22 places the officers who never achieved the rank of LCDR into groups based on their total years of active duty commissioned service (YCS) and then breaks them down further by when in their career they earned a master's degree. This is done to find common trends in this subgroup of data and lend a better understanding of the data used to create Tables 23 through 27. The reason to focus on the officers removed from the LCDR model is to help provide insight for future studies to better understand if there is a benefit to sending an officer earlier or later in his career to earn his master's.

In Table 22 the column labeled "Total" captures how many officers within this subgroup left the Navy with the total years of commissioned service found in the column labeled YCS. In the column titled "Chose to leave the Navy" the officers are narrowed down to only those who left the Navy voluntarily by fulfilling their service obligation, transferring to another branch of service, or accepting an incentive due to the Navy downsizing. The officers who fall into the category of voluntarily leaving the Navy are placed in groups based on when they earned their master's degree during their career. The main focus in this section is to find trends or values that standout based on how an officer earned a master's degree and whether he was forced or volunteered to leave the Navy. An important take away from Table 22 is that all of the officers who earned their master's degree in the first five years voluntarily left the Navy after no more than 10 YCS. This takeaway is important to find why 10 YCS is a critical breaking point for officers who earned their master's degree in the first five years to leave the Navy. Further analysis on this subgroup with more descriptive personal information such as number of dependents, health issues, total number of days out to sea, and overall job satisfaction

could help determine what role earning a master's early in an officers career plays in his decision to leave the Navy or if there is an another critical factor that contributes to this breakdown.

Table 22.   Total Years of Commissioned Service for Officers
Who Did Not Attain LCDR

YCS	Chose to leave the Navy	Started with master's degree	Earned master's in first 5 years	Earned master's after 5 years	Never earned master's degree	Total
< 5	2,132	34	9	3	2,086	2,326
6	356	10	3	3	340	373
7	603	6	13	10	574	617
8	384	3	24	9	348	399
9	85	2	3	1	79	97
10	48	1	5	8	34	65
11	20	1	0	5	14	82
12	13	0	0	9	4	66
13	4	0	0	3	1	9
14	1	0	0	0	1	1
15	2	0	0	1	1	2
Total	3,648	57	57	52	3,482	4,037

Table 23 looks at each column individually, and takes the number of officers who chose to leave in a particular YCS and divides it by the value for that same column found in the row labeled Total in Table 22. For example, in Table 23 the bolded value 16%, in the column labeled earned master's in first five years and row < 5 YCS, states that 16% of the officers who did not make LCDR and earned their master's in the first five years of their career voluntarily left the Navy with less than five years of commissioned service. Table 23 gives an easier visualization of when officers in each subgroup are more likely to leave the Navy. The majority of officers who earn their masters in the first five years leave after 8 years of commissioned service. This finding is important, especially for officers who attended graduate school in the first five years of their career, because this is when an officer will have to choose to sign on for more sea time to voluntarily separate. This may be a point where an officer who already has earned a master's degree could be

incentivized to remain in the Navy. This point will be further expanded upon in Section C of Chapter V.

Table 23.   Percentage of Officers Who Left the Navy Based on YCS and Master's Degree

YCS	Chose to leave the Navy	Started with master's degree	Earned master's in first 5 years	Earned master's after 5 years	Never earned master's degree	Total
< 5	58%	60%	**16%**	6%	60%	58%
6	10%	18%	5%	6%	11%	9%
7	17%	11%	23%	19%	16%	15%
8	11%	5%	42%	17%	10%	10%
9	2%	4%	5%	2%	2%	2%
10	1%	2%	9%	15%	1%	2%
11	1%	2%	0%	10%	0%	2%
12	0%	0%	0%	17%	0%	2%
13	0%	0%	0%	6%	0%	0%
14	0%	0%	0%	0%	0%	0%
15	0%	0%	0%	2%	0%	0%

Table 24 breaks down all of the officers into whether they were forced or volunteered to leave the Navy based on when they earned their master's degree. The important takeaway from Table 24 is that those officers who were sent to graduate school early volunteer to leave at a dramatically higher rate, relative to those who obtain their degree later in their careers. This is another important reason for further study to focus on what is causing these officers to voluntarily leave the Navy. It cannot be concluded that it is because of when they earned their master's degree based off of these data tables.

Table 24.   Number of Officers Forced and Volunteered to Leave the Navy
Before Becoming a LCDR

How officer left the Navy	Started with master's degree	Earned master's in first 5 years	Earned master's after 5 years	Never earned master's degree	Total
Forced	2	6	52	3,484	3,544
Volunteered	58	57	67	309	491
Total	60	63	119	3,793	4,035
Percentage Forced	3%	10%	44%	92%	88%
Percentage Volunteered	97%	90%	56%	8%	12%

Table 24 looks only at the officers who were removed from the LCDR model. Table 25 expands the data set to include the officers who made it to LCDR and removes all of the officers who did not have a code for how they left the Navy in the ODIS system. Table 25 focuses only on officers who received their master's degree during their career in the Navy to view any trends present when the data set expanded to the entire data set. Table 25 shows that the percentage of officers who are forced to leave the Navy decreases from Table 24 for all officers regardless of when they earned their master's degree.

Table 25.   Breakdown of Officers Who Were Forced and Volunteered
to Leave the Navy with Complete Data Set

How officer left Navy	Earned master's after five years		Earned master's before five years	
Volunteered	701	84%	93	92%
Forced	139	17%	8	8%
Total (Overall total = 4,975)	840	17%	101	2%

Tables 26 and 27 take the percentages presented in Table 25 to see how many of the officers made it to CDR before they volunteered or were forced to leave. Table 26 shows that the majority of officers who earn a master's degree in the first five years leave voluntarily before they make it to CDR. However, only a slight majority of officers who

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earn their master's Degree after five years make it to CDR. Tables 26 and 27 are important to see how the subgroup in Table 24 does not completely represent the entire group of observations.

Table 26.   Percentage of Officers Who Received their Master's in the First Five Years Who were Promoted to CDR

Made it to CDR?	Volunteered to Leave	Forced to Leave
Yes	22%	1%
No	70%	7%

Table 27.   Percentage of Officers Who Received their Master's After Five Years Who Were Promoted to CDR

Made it to CDR?	Volunteered to Leave	Forced to Leave
Yes	43%	5%
No	41%	12%

C.   GRADUATE EDUCATION COST

Figure 1 shows the basic career progression for an officer in the submarine community. Within a submarine officer's career there are two windows of opportunity for an officer to attend graduate school in the submarine warfare community if he does not go before nuclear power school. The first window of opportunity to attend graduate school is known as the Post Junior Officer Shore Tour which hits after approximately five years of active duty commissioned service. The second window of opportunity is known as the Post Department Head Shore Tour which falls in an officer's career path after at least ten years of active duty commissioned service. If an officer attends graduate school during the Post JO Shore Tour, then he will be attending graduate school as an O-3 and if he attends graduate school during Post DH Shore Tour then he will be an O-4.
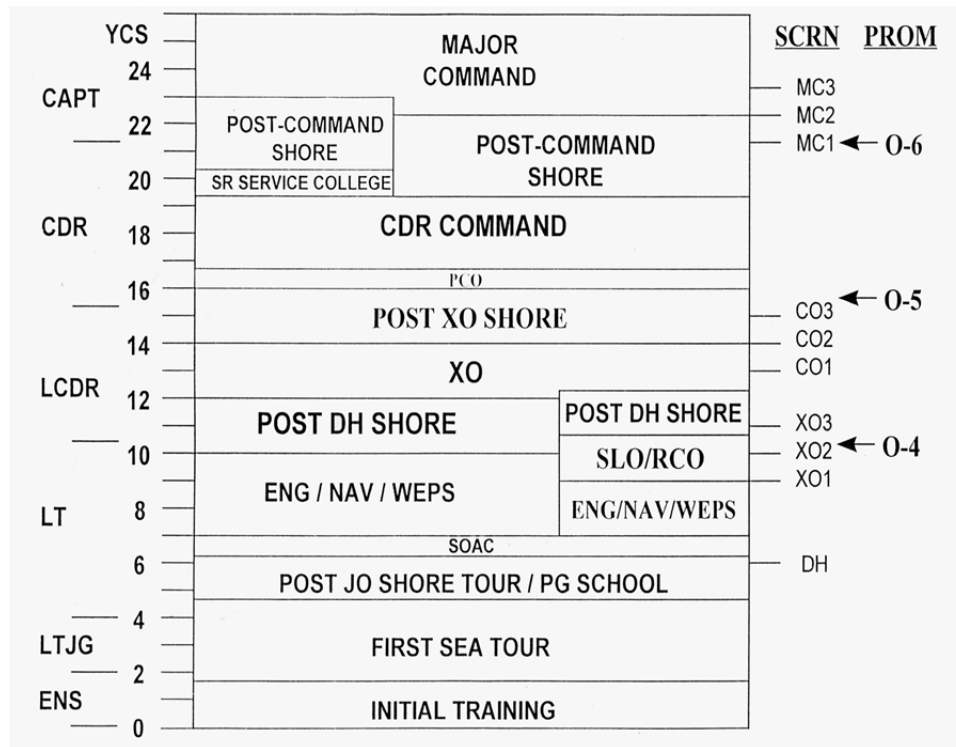
Figure 2.   Basic Career Progression for an Officer in the Submarine Community

Table 28 gives the monthly break down of a submarine officer's monthly pay. The base-pay reflects the 2013 pay charts that were approved by Congress on May 24, 2012. Base-pay is uniform for all military members regardless of branch of service. Basic Allowance for Housing (BAH) is based on the officer's pay-grade, zip-code, and dependency status. The values in Table 28 represent an officer in the year 2012 who does not have any dependents and lives in Monterey, CA where the Naval Postgraduate School is located. Basic Allowances for Subsistence (BAS) is intended to cover basic food and subsistence cost. BAS was established on January 1, 2012 and is uniform across all pay-grades. Continuous Submarine Incentive Pay (CONSUBPAY) was updated on September 21, 2011. Sub pay is designed to be paid to active duty naval service officers and enlisted personnel who engage in and remain in the submarine service on a career basis. The main difference between a submarine officer's pay and a SWO (N) is a SWO (N) does not receive CONSUBPAY. Instead surface officers receive sea pay, which is not included in Table 28 because it is based off of number of years an officer has been out to sea. The

value used for the number of years an officer has been out to sea could vary greatly based on each officer's career. To calculate base-pay and CONSUBPAY the following assumptions were made about each officer's years of commissioned service (YCS): an O-6 has at least 22 YCS, an O-5 has at least 16 YCS, an O-4 has at least 10 YCS, and O-3 has at least 4 YCS, an O-2 has at least 2 YCS, and an O-1 has less than 2 YCS. The charts used to calculate the values in Table 28 and 29 can be found in the Appendix.

Table 28.   Monthly Breakdown of Submarine Officer Pay

Paygrade	Base-pay	BAH w/o dependents	BAS	CONSUBPAY	Total
O-6	$9,781	$2,943.00	$239.96	$835	$13,798.96
O-5	$7,895	$2,715.00	$239.96	$835	$11,684.96
O-4	$6,528	$2,574.00	$239.96	$705	$10,046.96
O-3	$5,117	$2,241.00	$239.96	$510	$8,107.96
O-2	$3,774	$1,950.00	$239.96	$305	$6,268.96
O-1	$2,876	$1,608.00	$239.96	$230	$4,953.96

Table 29 takes the totals calculated in Table 28 and adds the additional cost for a submarine officer on a yearly basis. The yearly total was calculated by taking the monthly total and multiplying it by 12. The annual defense healthcare cost is the same that can be found in Table 30 from the Advanced Education and Competency Management office. Nuclear Career Annual Incentive Bonus (AIB) is found under the Nuclear Officer Incentive Pay Program. The AIB is a sum of money paid annually to nuclear-qualified officers who have completed their initial service requirement. O-1 and O-2 officers do not have AIB in Table 29 because these officers are still in their initial service obligation. Nuclear officers can also receive Continuation Pay (COPAY) which is not reflected in Table 29 because it is only paid to officers who agree to remain on active duty for an additional three to seven years beyond their existing service obligation. An officer who signs up for initial COPAY agreement for three years receives $17,500 per year. Each additional COPAY agreement the officer makes past the initial three years earns another $30,000 per year.

Table 29.   Annual Submarine Officer Pay

Paygrade	Monthly Total	Yearly Total	Annual Defense Healthcare Cost	AIB	Annual Total
O-6	$13,798.96	$165,587	$ 6,405	$12,000	$184,492
O-5	$11,684.96	$140,219	$ 6,405	$12,000	$159,124
O-4	$10,046.96	$120,563	$ 6,405	$12,000	$139,468
O-3	$8,107.96	$97,295	$ 6,405	$12,000	$116,200
O-2	$6,268.96	$75,227	$ 6,405	None	$81,632
O-1	$4,953.96	$59,447	$ 6,405	None	$65,852

Table 30 is from the Advanced Education and Competency Management Office used for Manpower Management programming to reflect the annual cost, designated by the Navy, for officers to attend graduate school under one of the fully funded programs.

Table 30.   Annual Cost of Fully Funded Graduate Programs

Pay Grade	FY-13 Military Manpower programming Rates	FY-13 Defense Healthcare Accrual	FY-13 Total
O-6	$207,847	$6,405	$214,252
O-5	$173,318	$6,405	$179,723
O-4	$149,244	$6,405	$155,649
O-3	$124,334	$6,405	$130,739
O-2	$99,190	$6,405	$105,595
O-1	$78,317	$6,405	$84,722

If the officer attends graduate school under a fully funded program as an O-3 he will cost the Navy $130,739 FY-13 dollars per year. If the officer attends the same program as an O-4, he will cost the Navy $155,649. There would also be additional cost accrued by the Navy if the officer had a family, because an officer's base-pay and basic housing allowance and health care cost increase with each additional dependent. If an officer is an O-3 or O-4 he has a much higher probability of having dependents, however the only cost that will come out of the graduate education fund is for the officer. For programs that are not funded by the Navy such as Civilian Funded Scholarship, Olmsted, and Officer Scholarship, the cost from Table 29 are used. The GEV program also uses the base cost from Table 29 and then adds an additional $40,000 to the base cost. Table 31

breaks down the service obligation required for the officer to complete after finishing his graduate degree and the average cost for an officer to attend graduate school in each of the programs based on the information in Tables 29 and 30.

Table 31.   Average Cost of Graduate Programs

Scholarship Program	Duration	JPME	Service Obligation	Total Cost
VGEP	1 year	1 course	No additional	$84,722 (O-1)
IGEP	1 year	None	No additional	$84,722 (O-1)
Civilian Funded	1 year	None	No additional	$65,852 (O-1)
Burke	2 years	None	Maximum 3 years	$311,298 (O-4)
				$261,478 (O-3)
Olmsted	2 years	None	3 years	$278,937 (O-4)
				$232,401 (O-3)
GEV	Max of 2 years	None	Maximum 3 years	$278,937 (O-4)
				$232,401 (O-3)
				+ maximum of $40,000
Officer Scholarship	Max of 2 years	None	Maximum 3 years	$278,937 (O-4)
				$232,401 (O-3)
Fully Funded	Max of 2 years	On-site	Maximum 3 years	$311,298 (O-4)
				$261,478 (O-3)
LEAD	1 year	On-site	2 DH Tours	$261,478 (O-3)

An officer sent to graduate school later in his career will cost the Navy more because he is paid more due to his rank and he will generally need more time at school to complete refresher courses before beginning the graduate curriculum. The refresher courses allow the officer to be adequately prepared for the course load required to complete his Master's degree program. However, there is not only an additional monetary cost amassed by the Navy for an officer to be sent to graduate school later in his career, there is also an opportunity cost. The opportunity cost that the Navy will suffer is the loss of an officer available to fill a shore billet where operational experience and nuclear training is necessary. There are multiple shore billets that require the nuclear training and experience an O-3 and O-4 have earlier in his or her career that an O-1 will not have completed when they attend graduate school under the IGEP, VGEP, or Civilian Funded Scholarship programs.

D.   SUMMARY

Utilizing logistic regression, the data shows that, once the selection bias is removed from the data by conditioning the selection of officers to only those that attained the rank of LCDR (O-4), receiving a master's degree during the first five years of his career is associated with a higher probability of remaining in the Navy until he reaches command than an officer who got his master's after five years of commissioned service. There are three main differences that must be taken into consideration: money, service obligation, and the likelihood the officer will remain in the Navy until he reaches O-5. The majority of the scholarship programs offered after five years of commissioned service allow officers two years to complete graduate school. If you only compare the cost of a single year of graduate education for an officer who receives his master's in the first five years versus later in his career he will cost the Navy on average $50,000 to $70,000 less per officer, as seen in Table 31, than an officer who earns his master's degree later in his career. If you compare the total cost of an officer receiving his master's in the first five years compared to later in his career, the officer who received his master's degree in the first five years costs the Navy on average $180,000 to $200,000 less. Also, the service obligation assumed if the officer earned his Master during his JO Shore Tour would be fulfilled during his DH Sea Tour, and if the officer earned his Master during his DH Shore Tour his obligation would be fulfilled during his Sea Tour as an Executive Officer. An officer must receive his master's degree after ten years of commissioned service for his service obligation to affect the goals of the nuclear community.

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VI. CONCLUSION

In the nuclear community, officers must have their master's degree before they can promote to CDR (O-5), which is at approximately 16 years of commissioned service. However, this community has a goal for all of its officers to get their master's degree before their sea tour as an Executive Officer, which is at approximately 12 years of commissioned service. This gives the officers in the nuclear community three opportunities to earn a master's degree. There are three problems that arise for the nuclear community during the window of opportunity to send its officers as LT and LCDR to get his or her master's degree. First, it costs the Navy substantially more financially and operationally to send an officer who is of a higher rank. Second, there are multiple billets that need officers who are nuclear qualified that these officers are required to fill during his or her JO and DH Shore tours. Third, the officer loses the opportunity to use the degree throughout his career the later he is sent to graduate school.

This thesis used a logistic regression model to determine the correlation between an officer receiving his master's degree and how likely he is to remain in the Navy until the rank of CDR (O-5). In order to control selection bias the first model conditioned on the officers having been in the nuclear community as a commissioned officer for at least ten years. In this model the timing of when an officer received his master's degree was insignificant. However, the next model conditioned on the officers remaining in the nuclear community until the rank of LCDR (O-4) found that the officer who received his master's in the first five years of his career was more likely to remain in the Navy and earn the rank of CDR than an officer who received his master's after five years of commissioned service. This finding is important because it shows that of the officers who attain the rank of LCDR, the individuals who earned their graduate degree earlier in their career have a greater likelihood of remaining in the Navy to earn the rank of CDR.

Since a logistic regression model that did not remove officers who left the nuclear community before LCDR could not give significant results due to selection bias, this thesis focused on the officers who were removed for the model conditioned on remaining in the nuclear community until LCDR. The focus on the officer removed from the LCDR

model does not give reason to change policy. However, an interesting finding is that 44% of the officers who earned their master's after five years and did not remain in the Navy was due to misconduct, unsatisfactory performance, or failure to promote compared to 10% of the officers who earned their master's in the first five years of their career.

A.   RECOMMENDATIONS FOR FURTHER STUDIES

To improve this study in the future, the main change would be to get data from the Officer Promotion History File and Officer Master Record Files maintained at the Defense Manpower Data Center in Monterey, CA. The ODIS system failed to label which graduate program 83% the officers participated in. In order to get a more accurate cost-benefit estimation for each program, we need to know which program the officer participated in. By knowing the program each officer participated in, we will better understand the most cost effective way to get as many officers to graduate school before they reach LCDR. This can be done by making the program the officer participated in a variable within the logistic regression model similar to the variable explained in Chapter IV "Navy Scholarship." The results from the logistic regression would identify which graduate programs do or do not improve an officer's likelihood of remaining in the Navy until the rank of CDR. The most cost-effective program would be a program that cost the Navy the least and improves the likelihood that an officer remains in the Navy until the rank of CDR.

Also, there are multiple ways the data could be expanded to give a more detailed representation of the nuclear community. The data set could be extended until year-group 1999 if the focus is for officers to get their degree before they become an Executive Officer (12-year mark) or year-group 1996 if the focus is for officers to make it to CDR (O-5). This would allow for women to be in the data-set. Since women are not included in this data set there is no evidence to observe if women's behavior deviate from the trends observed in this study. To find what effects an officer's decision to leave the nuclear community before a certain point, some demographic variable could be added to the model such as whether or not the officer has children, is married, his age upon commissioning, and the number of months he has been deployed. By finding the officer

who is most likely to remain in the nuclear community until CDR (O-5), the community will be more affective at choosing candidates to attend graduate school that will benefit the overall mission since there are only a limited number of officers that can be sent. Observing demographic trends will also show what changes could be made in the nuclear community to retain more officers.

B.   TAKEAWAYS

To observe officers over their complete career, one might want to use Survival Analysis. Type I right censoring could be used to observe if the officers remain in the nuclear community to a certain year point, either 12 years to make it to Executive Officer or 16 years to make it to commander. Type I left censoring observes what happens after the 12- or 16-year mark similar to the logistic regression used in this study. Type II censoring in Survival Analysis could be used by observing the number of times an officer promotes. This different approach would eliminate the problem of having to remove a large group of data points to control for selection bias.

The model conditioned on an officer earning the rank of LCDR shows evidence that going to graduate school in the first five years makes an officer more likely to promote to O-5. Based on these findings, it is important to keep educating officers early in their careers. This will allow the Navy to get the optimal benefit of specialty code and graduate degree. It also allows for more officers that have a wealth of operational knowledge and nuclear training to fill the shore billets that require nuclear training. There is no substantial evidence to encourage a drastic change because such a large group of officers had to be removed from the data set to control for selection bias. Removing a large number of observations is a concern because when looking at the complete data set 77% of the officers who earned their master's early did not remain in the Navy until LCDR. Also when observing the data points that were removed from the LCDR model, 44% of the officers who earned their master's after five years were forced to leave the Navy due to unsatisfactory performance, misconduct, or failure to promote, whereas only 10% of the individuals that received their masters in the first five years of their career were forced to leave the Navy.

The analysis completed in this thesis provides evidence to suggest that educating officers early in their careers is positively correlated with retention and promotion to the rank of CDR. However, we cannot directly link a cause/effect relationship to graduate education and officer retention, because the officers selected for early graduate education may have the predisposition to stay in the Navy regardless of the education due to the selection process. This impact of graduate education is an especially important finding during this time of budget cuts because sending an officer in the nuclear pipeline to graduate school early in their career will cost the Navy the least amount possible monetarily and allow for these officers to use their operational experience to fill key billets that require nuclear training during their shore tours later in their career path.

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